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ABSTRACT

Discrete mathematics and finite mathematics differ in a number of ways. First, finite mathematics has a longer history and is therefore more stable in terms of course content. Finite mathematics courses emphasize certain particular mathematical tools which are useful in solving the problems of business and the social sciences. Discrete mathematics courses, on the other hand, emphasize a particular guiding principle for all mathematical inquiry, namely the "algorithmic viewpoint." Discrete mathematics emphasizes mathematical induction and proofs, while finite mathematics avoids proofs and emphasizes applications and intuitive understanding. Because of this, finite mathematics is a terminal math course for many students, whereas discrete mathematics is an introductory course for its constituency. In spite of differences, courses in discrete and finite mathematics have similar prerequisites and cover a number of the same topics. The main difference between the two is the clientele served. Discrete mathematics courses serve mainly computer science students, and finite mathematics courses serve students from commerce and social science backgrounds. Therefore, and unfortunately, finite mathematics courses tend to be less rigorous. Given that mathematical expectations are rising for students in business and social sciences, a common course merging discrete and finite mathematics should be developed. A chart showing the overlap in the content of finite and discrete mathematics textbooks is attached. (AYC)

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Finite Mathematics and Discrete Mathematics - Is There a Difference?

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Finite Mathematics and Discrete Mathematics

Is There a Difference?

During the first half of the twentieth century the study of mathematics was the purview of natural and physical scientists, professional engineers and professional mathematicians. A knowledge of mathematics was not viewed as necessary for persons other than these. For students needing mathematical training, calculus was the only course available. All other courses which were offered either led to calculus or built upon it.

The onset of the Second World War changed this situation somewhat. In order for the vast manufacturing potential of the United States to be harnessed on behalf of the war effort, a new area of study called operations research was born. The types of problems that emerged from this area involved combinatorics and optimization of processes, problems for which the calculus was ill-suited.

After the war, the simplex algorithm was developed by George B. Dantzig as an outgrowth of operations research (Albers & Reid, 1986). This method for maximizing a linear function of several variables constrained by linear inequalities marked operations research as an area which used sophisticated mathematical techniques. The dependence of operations research on the use of such esoteric techniques marked it as a mathematical science and legitimized it as an area of academic inquiry.

Also as a result of the Second World War came the development of the digital computer. Although originally used

strictly for military purposes, it soon became apparent that such a machine could make available to a large number of disciplines mathematical techniques whose use had not been previously feasible because of their computational complexity.

In addition to these disciplinary and technological changes, the clientele requiring some knowledge of mathematics grew in size. Persons in the social sciences, business and numerous other areas required knowlege of mathematical concepts as mathematical techniques made inroads into their disciplines. However, the kinds of concepts required involved notions of finite sets and discrete processes rather than the infinite sets and continuous processes associated with calculus.

The aforementioned situations worked to create a demand for the course which is now called finite mathematics. It had its beginning in the early 1950's at Dartmouth College when John Kemeny and several others devised a course whose original audience was envisioned to be primarily social science students (Kemeny, 1983, p. 202). Despite the intended clientele, the material and methods of the course were soon seen to be applicable to business as well. During the development of the course, the designers found that there was no suitable textbook. To fill this void, the book Introduction to Finite Mathematics by Kemeny, Snell and Thompson (1957) was written. This book has become the standard by which all subsequent finite mathematics books are measured.

Finite mathematics was the first alternative to calculus

available to the growing collection of disciplines attempting to utilize mathematical methods in their modes of inquiry. Since these disciplines had not previously used mathematics to any great extent, their students' mathematical backgrounds were often deficient. This necessitated classroom methods different from those found in most calculus courses. Finite mathematics courses stressed applications rather than abstract theory. Logic and set theory, for example, were dealt with in a less formal way than if they were taught to a mathematically sophisticated audience. There was a definite effort to avoid axiomatics and excessive rigor in the presentation of material (Malkevitch and Meyer, 1974).

The content of finite mathematics has stabilized over the years. The course normally requires only two years of high school algebra as a prerequisite. On this base of high school algebra, the student is expected to learn the matrix algebra necessary for solving systems of linear equations and performing the manipulations attendant to the simplex method. Table 1 shows the topics present in twelve recent finite mathematics books. As can be seen from Table 1, there is

[Insert Table 1 about here]

considerable agreement about the topics which should constitute such a course. The simplex method, mathematics of finance, probability and statistics, matrices and Markov processes appear in each text.

Finally, it should be noted that while finite mathematics is an alternative to calculus, it has never threatened the position of calculus as the predominant introductory college level mathematics course. This is

because it is an alternative for a different audience, the collection of people who come from traditionally non-mathematical disciplines which have begun to utilize mathematical methods. Calculus continues to reign supreme with its original natural and physical science constituency.

The history of discrete mathematics is more brief than that of finite mathematics. Discrete mathematics courses were developed in the late 1970's and early 1980's in response to the need of computer scientists to investigate the mathematics of program analysis, data storage configurations and algorithm efficiency.

The development of discrete mathematics has been aided by the efforts of a number of distinguished proponents who see the audience of the course as larger than just computer scientists. Persons such as Anthony Ralston (1984) and Steven Maurer (1985) have forcefully argued that discrete mathematics is the wave of the future for all students including those who would presently start college mathematics with calculus. These two see discrete mathematics as a replacement for calculus in the classical mathematics curriculum.

The above claim has been made with almost missionary zeal. Indeed, in one sense discrete mathematics has become a philosophical position rather than merely a branch of mathematics. Maurer makes the claim that the algorithmic way of life is best. "Thinking with and about algorithms can unify all one's mathematical endeavors. It also extends the range of one's mathematics and provides as satisfying an esthetic as the old existential esthetic...(Maurer, 1985,

p.2). One consequence of this point of view is that the content of a discrete mathematics course is not as important as the algorithmic viewpoint (Hart, 1985). In other words, course content is most important as a vehicle for communicating algorithmic thinking. Therefore, a great variety of content is possible as long as the viewpoint is transmitted (Case, 1988, p. 215).

Given the relative youth of the discrete mathematics movement and the stress placed on point of view rather than content, it should be of little surprise that there is presently much variation in the choice of topics for a discrete mathematics course. Recent years have seen the production of a barrage of discrete mathematics texts. An examination of some of these texts can help to determine if any topical consensus exists about course content. Table 2 shows the contents of twelve recent discrete mathematics

[Insert Table 2 about here]

textbooks. One or two topics seem to be common to all the books, but clearly there is less clustering than was observed in Table 1. It should be noted, however, that there is substantial overlap in the topics that are a part of the discrete texts and the finite texts.

In spite of the seemingly recent origin of the algorithmic viewpoint, it can be viewed as the recurrence of a previous mathematical philosophy. The point of view is basically constructivist and as such is in the tradition of the mathematical intuitionism first propounded by the Dutch mathematician L.E.J. Brouwer around 1908 (Eves & Newsom, 1965, p.302). For an intuitionist, a mathematical entity

whose existence is to be proven must be shown to be constructible in a finite number of steps. In other words, an algorithm must be given. Hence, intuitionism constitutes a historical antecedent for the algorithmic viewpoint of discrete mathematics. The advent of the computer then has merely resuscitated a previous viewpoint rather than initiated a new one.

To summarize, it appears that finite mathematics courses emphasize some particular mathematical tools which are useful in solving problems of business and social science. Discrete mathematics courses emphasize a particular guiding principle for all mathematical inquiry, namely the "algorithmic viewpoint". Because of this, finite mathematics is a terminal mathematics course for many of the students who take it while discrete mathematics is an introductory course for its constituency.

There are other contrasts between the two. Discrete mathematics is often touted as a good course in which to teach students how to do proofs (Maurer, 1989, p.1). This is because of the fact that mathematical induction occupies an important position in the development of certain topics in discrete mathematics. By contrast, finite mathematics avoids proofs and emphasizes applications and intuitive understanding.

Finally, the constituencies served by the two courses are different. At present discrete mathematics mainly serves students of computer science. On the other hand, finite mathematics students are mostly from commerce and social science.

The claimed prerequisites for discrete mathematics and finite mathematics are fundamentally the same. In Kemeny et al (1957), the introduction to the text states that "the only prerequisite for this book is the mathematical maturity obtained from two and a half or more years of high school mathematics." Nearly the same is claimed for discrete mathematics. For example, a representative text states that "although the formal mathematics prerequisites are minimal (calculus is not required) a certain sophistication is required" (Johnsonbaugh, 1986, p. v). In other words, both courses require some " mathematical common sense" if the student is to have success. ("Mathematical common sense" consists of number sense, symbol sense and function sense. For a more definitive treatment of the topic see pages 46-54 in Everybody Counts (1989)).

Will discrete mathematics and finite mathematics converge in the near future? To answer this, we must ask what is it that actually makes the two courses different? In my view, it is the clientele served. The topics of the courses overlap tremendously, but since we have higher mathematical expectations of students in computer science than we do of students in commerce and social science, we design a more demanding course for the former. Mathematical expectations are rising for students in business and social science (Maurer, 1989). Since this is the case, a common course for these areas and computer science makes sense. We need to educate both groups in better mathematical thinking, not merely the more mathematically sophisticated group.

Table 1

Representative Finite Mathematics Texts and Topics

Texts (see next page)

Topics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Algebra Review	*				*						*	
Functions & Graphs	*	*	*			*					*	
Relations	*											
Modeling	*											
Linear Prog (Geometric)	*	*	*	*	*	*	*	*	*	*	*	*
Linear Prog (Simplex)	*	*	*	*	*	*	*	*	*	*	*	*
Combinatorics	*		*				*					
Probability	*	*	*	*	*	*	*	*	*	*	*	*
Statistics	*	*	*	*	*	*	*	*	*	*	*	*
Graph Theory	*			*						*		
Game Theory	*	*	*	*		*				*	*	*
Markov Processes	*		*	*	*	*	*	*	*	*	*	*
Math of Finance	*	*	*	*	*	*	*	*	*	*	*	*
Sets		*	*	*		*			*	*	*	*
Logic							*					
Calculators		*										
Linear Systems	*	*	*	*	*	*	*	*	*	*	*	*
Matrices	*	*	*	*	*	*	*	*	*	*	*	*

List of Texts - Table 1 (cont'd)

1. Finite Mathematics, Bittinger & Crown, Addison-Wesley, 1989.

2. Applied Finite Mathematics, Coppins & Umberger, Addison-Wesley, 1986.

3. Finite Mathematics and Its Applications, Goldstein, Schneider & Siegel, Prentice Hall, 1988.

4. Finite Mathematics, Maki & Thompson, McGraw-Hill, 1989.

5. Applied Finite Mathematics, Hunkins & Mugridge, PWS-Kent, 1985.

6. Applied Finite Mathematics, Tan, PWS-Kent, 1987.

7. Finite Mathematics, Smith, Brooks-Cole, 1988.

8. Finite Mathematics with Applications to Business and Social Science, Wheeler & Peoples, Brooks-Cole, 1987.

9. Applied Finite Mathematics, Hoenig, Random House, 1989.

10. Finite Mathematics and Its Applications, Farlow & Haggard, Random House, 1988.

11. Finite Mathematics, Rolf & Williams, William C. Brown, 1988.

12. Finite Mathematics for Management, Life and Social Sciences, D.C. Heath, 1989.

Table 2

Representative Discrete Mathematics Texts and Topics

Texts (see next page)

Topics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Discrete Models	*									*		
Logic	*	*	*	*		*	*		*	*	*	*
Algorithms	*	*	*			*			*	*	*	*
Number Theory	*											
Recursion	*				*			*				*
Combinatorics	*	*	*	*	*	*		*	*	*	*	*
Probability	*				*	*			*			
Relations	*		*	*	*	*	*		*		*	*
Graph Theory	*	*	*	*		*	*	*		*	*	*
Trees	*	*		*	*			*			*	*
Sets		*		*	*	*	*		*	*	*	*
Computer Arithmetic		*							*			
Groups				*		*	*					
Boolean Alg					*	*			*	*	*	*
Finite State Machines					*							*
Mathematical Induction				*	*		*	*	*			
Data Structures			*									
Functions				*	*	*	*		*			
Matrices				*	*				*		*	*
Languages & Grammars					*					*		*
Generating Functions								*				
Game Theory										*		

List of Texts - Table 2 (cont'd)

1. Introduction to Discrete Mathematics, Bradley, Addison-Wesley, 1988.

2. An Introduction to Discrete Mathematics and its Applications, Kalmanson, Addison-Wesley, 1986.

3. Introduction to Discrete Mathematics, Althoen & Bumcroft, PWS-Kent, 1988.

4. Discrete Mathematics, Ross & Wright, Prentice-Hall, 1988.

5. Introductory Discrete Structures, Kolman & Busby, Prentice-Hall, 1987.

6. Discrete Mathematics with Computer Applications, Skvarcius & Robinson, Benjamin Cummings, 1986.

7. Foundations of Discrete Mathematics, Polimeri & Straight, Brooks-Cole, 1985.

8. Discrete Mathematics, Applied Combinatorics & Graph Theory, Townsend, Benjamin Cummings, 1987.

9. A First Course in Discrete Mathematics, Molluzzo & Buckley, Wadsworth, 1986.

10. Introduction to Discrete Mathematics, McEliece, Ash & Ash, Random House, 1989.

11. Discrete Mathematics and its Applications, Rosen, Random House, 1988.

12. Discrete Mathematics, Johnsonbaugh, MacMillan, 1986.

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